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South Hadley Wastewater Treatment Plant

NPDES Permit #MA0100455

Annual Nitrogen Optimization Report - 2016

1) Summary of Activities related to optimizing Nitrogen removal efficiencies

Section B of the National Pollutant Discharge Elimination System (NPDES) Permit for the South Hadley Wastewater Treatment Plant (WWTP), effective December 1, 2012, contains Special Conditions for Nitrogen. The conditions include a Nitrogen Optimization Study (completed), implementation of operational changes to maintain the mass discharge of total Nitrogen less than the existing annual average loading, and an annual report summarizing Nitrogen optimization activities, trends, and loading for the previous calendar year.

The South Hadley WWTP has tried to incorporate nitrification and denitrification in its daily operations for the past few years, with varying results. A key limiting factor for this facility is low dissolved oxygen in the aeration tanks. Even at full operation, it is difficult to achieve, let alone maintain, a dissolved oxygen level in the tanks over one milligram per liter (mg/L), especially in the warmer months when it is needed the most. As previously reported in the 2014 annual report, during the second half of 2014, plant staff began to adjust operations to achieve some Nitrogen reduction by nitrifying/denitrifying. There was some success, however the plant struggled with Nocardia, foam, low Dissolved Oxygen (DO) and incomplete nitrification resulting in high chlorine demand and associated effluent violations. The Plant Managers determined that additional assistance was needed to fully understand and control what was happening in the plant during the nitrification / denitrification process in order to reduce associated operational issues and effluent violations. In December, the Plant executed a four month contract with Grant Weaver of The Water Planet.

Initially, the focus for 2015 was on implementing operational changes to gradually shift the plant operations to naturally enhance nitrogen removal. Fairly quickly, the plant showed improvements in nitrifying and nitrate removal, but also began experiencing problems with Nocardia, foam and lower alkalinity in the aeration tanks. One possibility for this was the low influent BOD holding the process back. This trend continued through May, with some improvements offset by operational issues. The second half of 2015 was made more difficult by previously scheduled concrete resurfacing of two of the aeration tanks. Plant alkalinity and pH continued to decrease, and the plant began experiencing problems with odors, resulting in numerous complaints in July. Grant Weaver determined that we may have been running a little septic, and the nitrification process was not completing in the plant but rather in the thickeners. This was probably due to both the lack of oxygen in the plant and lack of BOD to drive the process. He recommended we quickly get rid of the material in the thickeners, and to continue to increase the air until the aerators were on continuously. In August, the decision was made to

postpone actively trying to nitrify/denitrify and focus more on operating effectively until the aeration tank project completed, which was in December.

The Nitrogen Optimization Plan for 2016 was to continue trying to follow through on the same operational type program proposed by Grant Weaver of the Water Planet for 2015, since there were no construction projects to interfere. Unfortunately, the plant began struggling with filamentous bacteria early in the year, prior to actively trying to nitrify / denitrify, and the focus shifted to operating effectively and managing the bacteria. Plant staff met with Grant Weaver twice in May to address issues, and how to get the Nitrogen optimization back on track. He recommended trying to maintain a dissolved oxygen (D.O.) of 1.5 mg/L in the aerobic tanks, and maintaining current wasting/recycling levels to boost the BOD. Shortly after implementing the changes, the plant began receiving odor complaints. Plant staff again met with Grant Weaver on May 19th, and made some additional adjustments, however the odor complaints became more frequent. On June 16, the decision was made to revert back to the conventional treatment the plant was designed for. It should be noted that the battle with the filamentous bacteria is still ongoing.

Aside from the problem with the filamentous bacteria, the plant still experienced the same deficiencies in 2016 that interfered with the nitrification / denitrification process in 2015; specifically, low influent BOD and low D.O. in the aeration tanks. The plant has had a long history with low influent BOD's, at one point making it difficult to meet the 85% removal required under the NPDES Permits. Although there has been some improvement over the years, the plant still struggles with low influent BOD periodically. In 2015, the monthly average influent BOD concentrations ranged from 101 to 164 mg/L, with the majority on the lower side. Many individual results were well under 100 mg/L. This trend continued in 2016, although there was an increase in BOD in the last quarter. Efforts to supplement the low influent BOD included increasing return activated sludge volumes, and wasting from the thickeners directly to the primaries. Low D.O. in the aeration tanks has been a concern since the aerators were replaced in the 2008 upgrade, and identified as a limiting factor in the Nitrogen Study that was completed under this Permit. Although the dissolved oxygen numbers are good in the colder months, usually by May it drops off and remains under 1 mg/L for the warmer months when it is needed most. Given these deficiencies, and the results of past attempts, it is unlikely that this facility can effectively operate in a way to enhance Nitrogen removal without significant capital costs.

2) Annual Nitrogen Discharge Loading

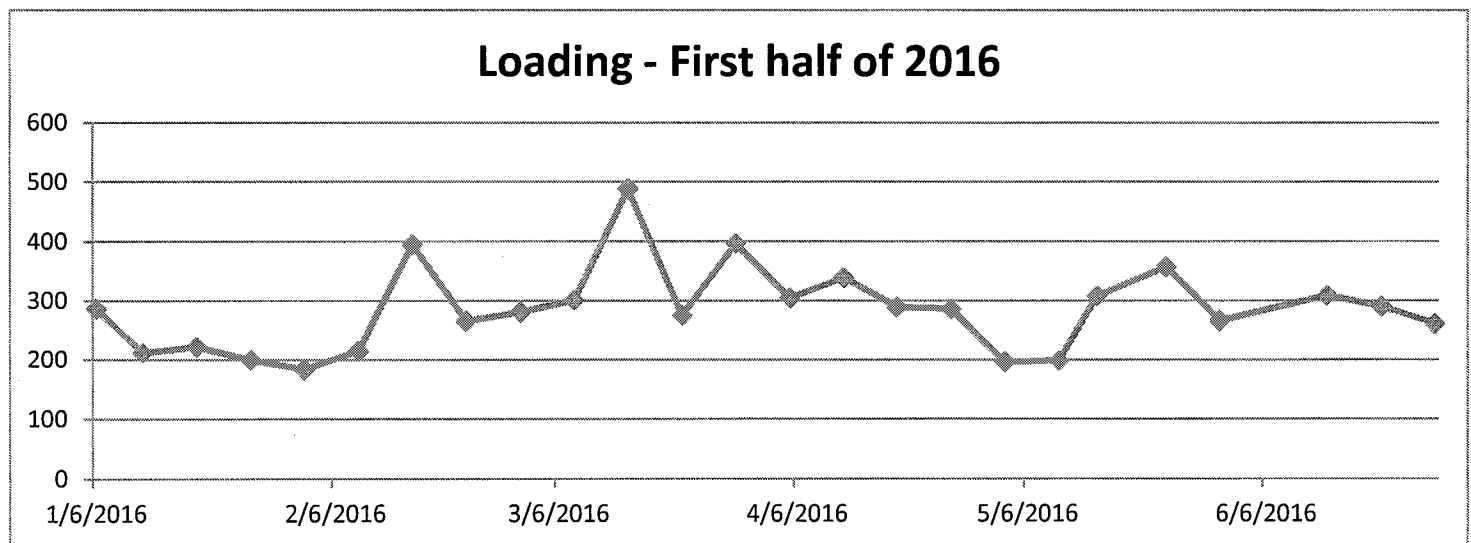
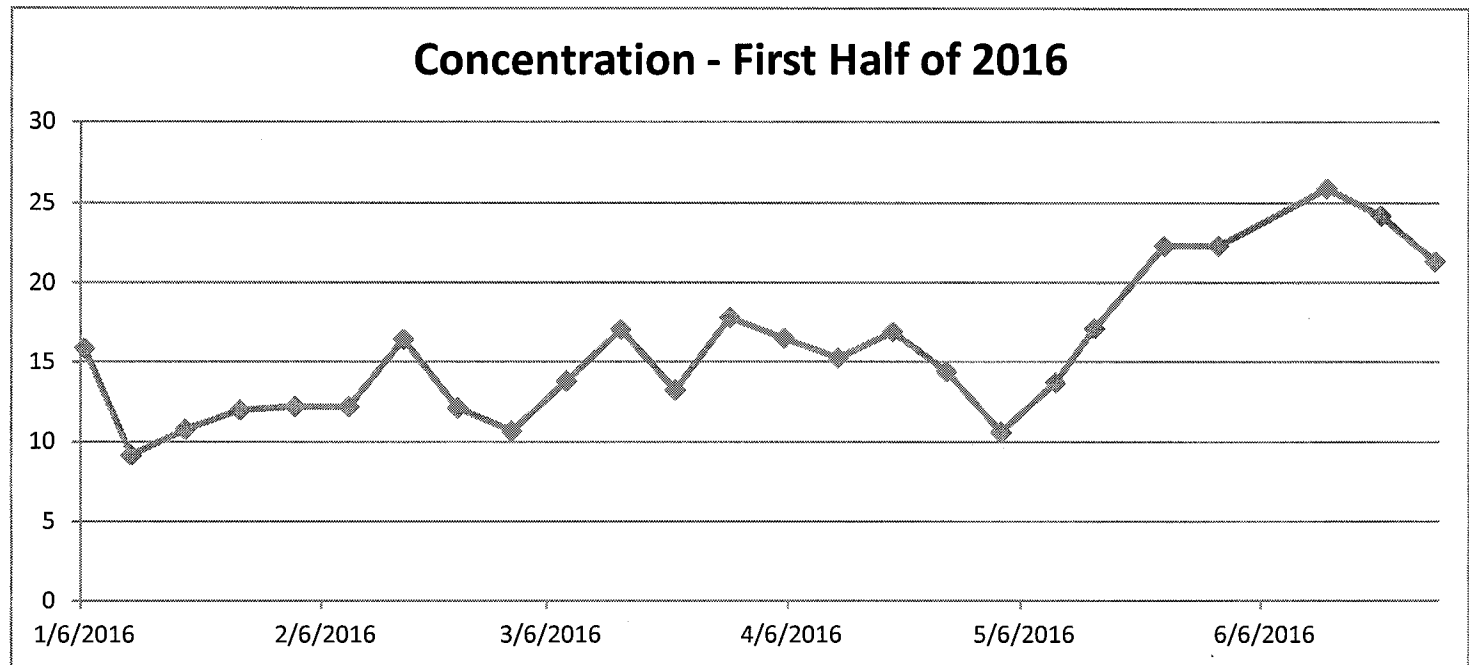
The Nitrogen effluent data for the South Hadley WWTP for calendar year 2016 has been summarized in the attached spreadsheet and graphs. The annual average for total Nitrogen loading was 273 pounds per day, based on 51 data points. This is slightly less than the 321 pounds per day average for 2015, and well below the annual average referenced in the NPDES Permit of 682 pounds per day without any significant modifications and minimal Nitrogen optimization.

3) Trends relative to the previous year

The current NPDES Permit requires weekly effluent monitoring for Ammonia, Total Kjeldahl Nitrogen (TKN), Nitrate and Nitrite. The 2015 monthly data is included in the last 2 columns on the 2016 data summary as a reference. As shown on the attached graphs, although the average monthly concentrations were higher in 2016, the average monthly loadings were lower. The monthly average loadings were less than or equal to 2015 for 10 of the 12 months. Given the higher nitrogen concentrations, this is more likely attributable to extremely low rainfalls combined with significantly lower plant flows and reduced industrial input, rather than the attempts at nitrifying and denitrifying.

2016 Nitrogen Data

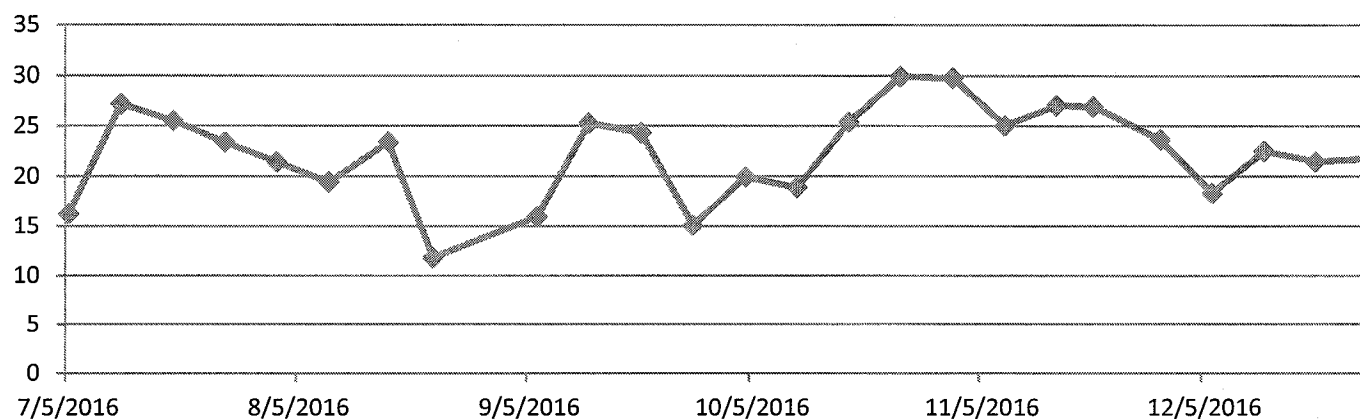
2016 Effluent Data	2016 Nitrogen N Tot mg/L	2016 Nitrogen N Tot Lbs/day
1/6/2016	15.85	285.9
1/12/2016	9.15	211.5
1/19/2016	10.75	221.6
1/26/2016	11.97	199.1
2/2/2016	12.19	183.3
2/9/2016	12.19	215.2
2/16/2016	16.41	394.9
2/23/2016	12.08	265.3
3/1/2016	10.66	280.4
3/8/2016	13.8	300.7
3/15/2016	17.03	488.2
3/22/2016	13.23	274.8
3/29/2016	17.8	396.1
4/5/2016	16.46	304.2
4/12/2016	15.25	338.2
4/19/2016	16.86	289.3
4/26/2016	14.37	285.5
5/3/2016	10.6	195.8
5/10/2016	13.7	198.2
5/15/2016	17.1	307.4
5/24/2016	22.3	356.9
5/31/2016	22.3	265.7
6/14/2016	25.9	308.6
6/21/2016	24.2	289.1
6/28/2016	21.3	260.9



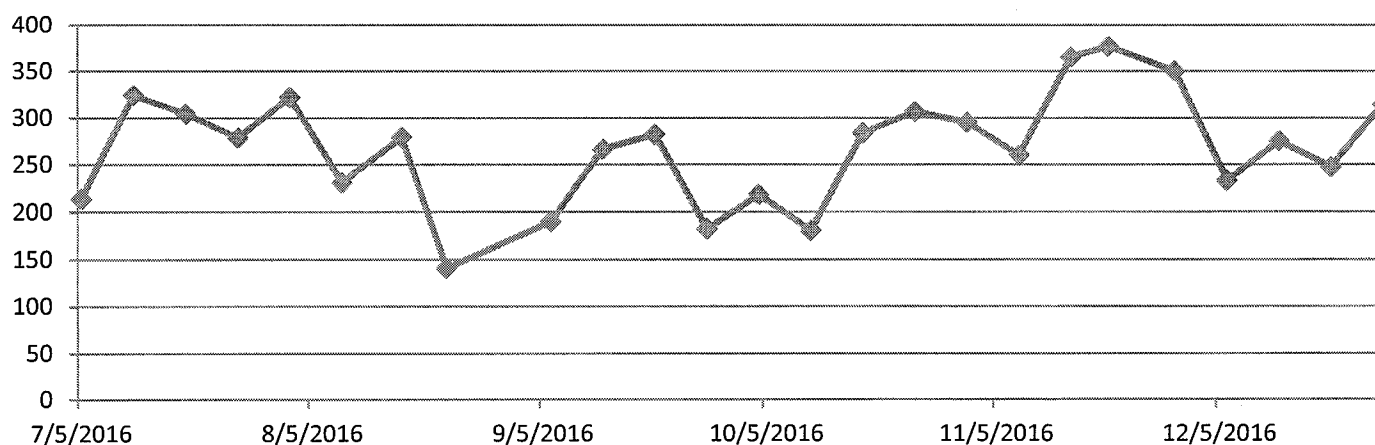
2016 Nitrogen Data

2016 Effluent Data	2016 Nitrogen N Tot mg/L	2016 Nitrogen N Tot Lbs/day
7/5/2016	16.27	214
7/12/2016	27.17	324
7/19/2016	25.53	304.2
7/26/2016	23.39	278.7
8/2/2016	21.42	321.9
8/9/2016	19.43	231.4
8/17/2016	23.41	278.9
8/23/2016	11.82	140.8
8/30/2016	13.74	163.3
9/6/2016	15.94	189.7
9/13/2016	25.3	266.6
9/20/2016	24.33	282.1
9/27/2016	15.06	182.1
10/4/2016	19.96	218.2
10/11/2016	18.87	180.4
10/18/2016	25.39	283.8
10/25/2016	29.93	306.5
11/1/2016	29.77	295.1
11/8/2016	25.09	260.3
11/15/2016	27.05	365.5
11/20/2016	26.94	376.5
11/29/2016	23.69	350
12/6/2016	18.37	233
12/13/2016	22.53	274.9
12/20/2016	21.49	247.4
12/27/2016	21.77	314.3

Concentration - Second Half of 2016



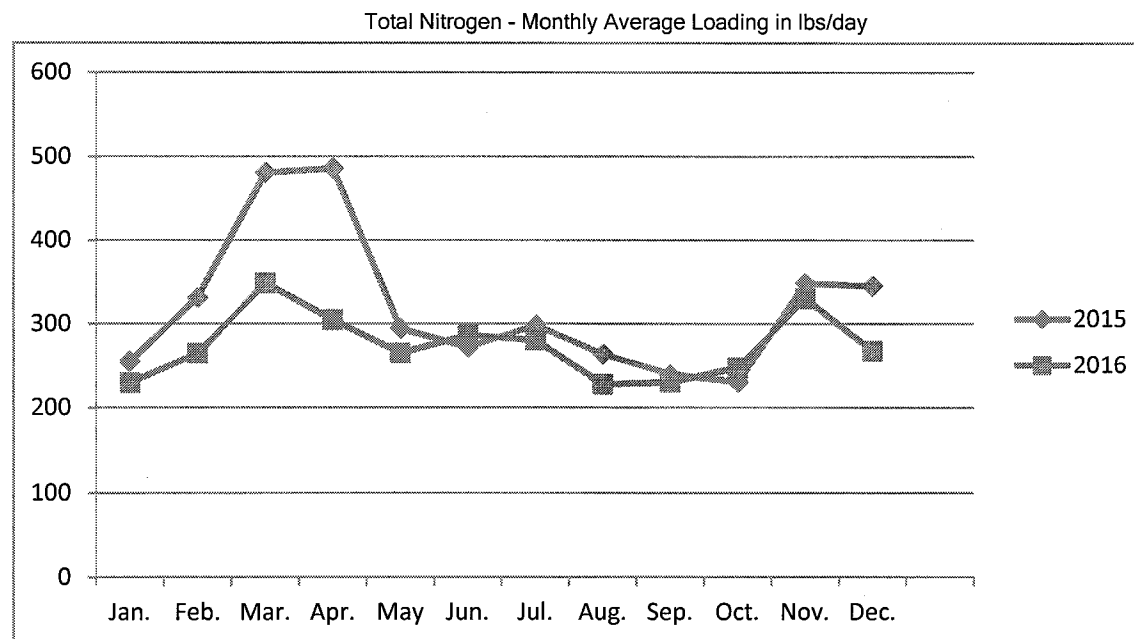
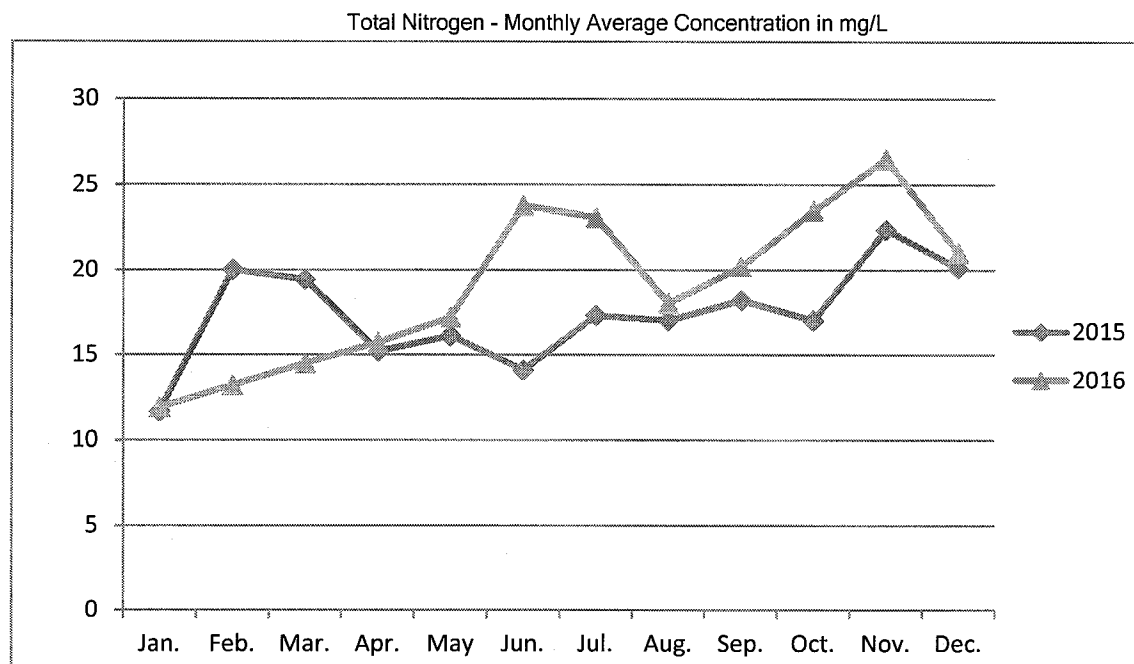
Loading - Second Half of 2016



2015 - 2016 Monthly Average Nitrogen Data

	2015 Nitrogen N Tot mg/L	2015 Nitrogen N Tot Lbs/day
Jan.	11.7	255.1
Feb.	20	331.1
Mar.	19.4	480.7
Apr.	15.2	485.8
May	16.1	294
Jun.	14.1	271.9
Jul.	17.3	298.2
Aug.	17	263.4
Sep.	18.2	239.2
Oct.	17	230.4
Nov.	22.4	347.6
Dec.	20.1	344.5

	2016 Nitrogen N Tot mg/L	2016 Nitrogen N Tot Lbs/day
Jan.	11.9	229.5
Feb.	13.2	264.7
Mar.	14.5	348
Apr.	15.7	304.3
May	17.2	264.8
Jun.	23.8	286.2
Jul.	23.1	280.2
Aug.	18	227.3
Sep.	20.2	230.1
Oct.	23.5	247.2
Nov.	26.5	329.5
Dec.	21	267.4



2016 Nitrogen Data

2016 Effluent Data	Rain Inches/Day	Daily Flow MGD	Ammonia Nh3 N mg/L	TKN mg/L	Nitrate NO3 mg/L	Nitrite NO2 mg/L	Nitrogen N Total mg/L	Nitrogen N Total Lbs/day	2015 Nitrogen N Total mg/L	2015 Nitrogen N Total Lbs/day
January										
1/6/2016	0	2.2	0.77	1.75	14	<0.1	15.85	285.9	7.11	160.2
1/12/2016	0	2.8	0.35	0.98	8.07	<0.1	9.15	211.5	11.7	233.4
1/19/2016	0	2.5	0.42	1.19	9.46	<0.1	10.75	221.6	10.99	274.2
1/26/2016	0	2	0.35	1.47	10.4	<0.1	11.97	199.1	17.14	352.6
Sum			1.890	5.4	41.930	<0.400	47.720	918.072	46.94	1020.3
Avg		2.33	0.473	1.3	10.483	<0.100	11.930	229.518	11.74	255.1
Max			0.770	1.8	14.000	<0.100	15.850	285.936	17.14	352.6
Min			0.350	1.0	8.070	<0.100	9.150	199.123	7.11	160.2
February										
2/2/2016	0	1.8	0.28	1.19	10.9	<0.1	12.19	183.3	15.34	256.2
2/9/2016	0	2.1	0.42	1.19	10.9	<0.1	12.19	215.2	19.54	337.3
2/16/2016	0.35	2.9	1.05	3.71	12.6	<0.1	16.41	394.9	20.45	339.6
2/23/2016	0.27	2.6	0.42	0.98	11	<0.1	12.08	265.3	24.54	391.2
Sum			2.170	7.1	45.400	<0.400	52.870	1,058.756	79.87	1324.4
Avg		2.78	0.543	1.8	11.350	<0.100	13.218	264.689	19.97	331.1
Max			1.050	3.7	12.600	<0.100	16.410	394.941	24.54	391.2
Min			0.280	1.0	10.900	<0.100	12.080	183.274	15.34	256.2
March										
3/1/2016	0.62	3.15	0.42	0.84	9.72	<0.1	10.66	280.4	24.14	402.56
3/8/2016	0	2.61	0.63	1.4	12.3	<0.1	13.8	300.7	30.43	639.4
3/15/2016	0.11	3.44	1.61	2.1	14.8	0.127	17.03	488.2	13.91	477.6
3/22/2016	0	2.49	0.21	0.63	12.5	<0.1	13.23	274.8	15.12	389.9
3/29/2016	0	2.67	1.05	1.61	16	0.189	17.8	396.1	13.52	493.9
Sum			3.920	6.6	65.320	<0.616	72.520	1,740.207	97.12	2403.4
Avg		2.76	0.784	1.3	13.064	<0.123	14.504	348.041	19.42	480.7
Max			1.610	2.1	16.000	0.189	17.800	488.159	30.43	639.4
Min			0.210	0.6	9.720	<0.100	10.660	274.767	13.52	389.9
April										
4/5/2016	0	2.2	1.33	1.75	14.5	0.205	16.46	304.2	13.07	449.9
4/12/2016	0.24	2.7	0.49	1.05	14.1	<0.1	15.25	338.2	13.85	448.5
4/19/2016	0	2.1	0.35	1.26	15.5	<0.1	16.86	289.3	14.87	560.6
4/26/2016	0.35	2.4	0.28	1.47	12.8	<0.1	14.37	285.5	18.98	484.2
Sum			2.450	5.5	56.900	<0.505	62.940	1217.17	60.77	1943.2
Avg		2.23	0.613	1.4	14.225	<0.126	15.735	304.29	15.19	485.8
Max			1.330	1.8	15.500	0.205	16.860	338.21	18.98	560.6
Min			0.280	1.1	12.800	<0.100	14.370	285.45	13.07	448.5

2016 Nitrogen Data

2016 Effluent Data	Rain Inches/Day	Daily Flow MGD	Ammonia Nh3 N mg/L	TKN mg/L	Nitrate NO3 mg/L	Nitrite NO2 mg/L	Nitrogen N Total mg/L	Nitrogen N Total Lbs/day	2015 Nitrogen N Total mg/L	2015 Nitrogen N Total Lbs/day
May										
5/3/2016	0.08	2.21	0.28	1.19	9.31	<0.1	10.6	195.8	18.26	387.2
5/10/2016	0	1.73	0.35	1.47	12.1	<0.1	13.7	198.2	17.51	307.6
5/15/2016	0	2.16	0.84	1.47	15.5	0.119	17.1	307.4	15.46	272.9
5/24/2016	0.23	1.92	3.64	4.69	17.2	0.385	22.3	356.9	13.31	208.2
5/31/2016	0	1.43	2.59	3.29	18.6	0.415	22.3	265.7		
Sum			7.700	12.1	72.710	<1.119	86.000	1,323.943	64.54	1175.9
Avg		1.76	1.540	2.4	14.542	<0.224	17.200	264.789	16.12	294
Max			3.640	4.7	18.600	0.415	22.300	356.889	18.26	387.2
Min			0.280	1.2	9.310	<0.100	10.600	195.801	13.31	208.2
June										
6/7/2016	0.28	1.6	3.29	3.78	No Data	No Data	No Data	No Data	12.3	300.9
6/14/2016	0	1.43	7.14	7.7	17.7	0.525	25.9	308.6	11.3	180.8
6/21/2016	0	1.43	1.75	2.59	21.3	0.322	24.2	289.1	10.6	182.6
6/28/2016	0.02	1.47	1.47	2.87	17.9	0.561	21.3	260.9	21.1	388.9
									15.1	306.4
Sum			13.650	16.9	56.900	1.408	71.400	858.664	70.4	1359.6
Avg		1.47	3.413	4.2	18.967	0.469	23.800	286.221	14.1	271.9
Max			7.140	7.7	21.300	0.561	25.900	308.610	21.1	388.9
Min			1.470	2.6	17.700	0.322	21.300	260.912	10.6	180.8
July										
7/5/2016	0	1.58	9.87	12.9	2.88	0.492	16.27	214	13.25	240.7
7/12/2016	0	1.43	23.8	24.8	2.12	0.249	27.17	324	16.22	330.7
7/19/2016	0	1.43	16.2	22.9	2.22	0.409	25.53	304.2	21.96	350.6
7/26/2016	0	1.43	17.4	21.2	1.63	0.564	23.39	278.7	17.63	270.7
Sum			67.270	81.8	8.850	1.714	92.360	1,120.874	69.06	1192.6
Avg		1.46	16.818	20.5	2.213	0.429	23.090	280.219	17.27	298.2
Max			23.800	24.8	2.880	0.564	27.170	323.964	21.96	350.6
Min			9.870	12.9	1.630	0.249	16.270	214.006	13.25	240.7
August										
8/2/2016	0	1.8	15.8	20.1	1.22	<0.1	21.42	321.9	21.13	334.5
8/9/2016	0	1.43	16.2	18.1	0.842	0.491	19.43	231.4	22.45	392.6
8/17/2016	0	1.43	14.2	22.4	0.609	0.4	23.41	278.9	18.65	245.3
8/23/2016	0	1.43	8.4	11.1	0.493	0.229	11.82	140.8	5.72	81.2
8/30/2017	0	1.42	6.5	12.8	0.441	<0.5	13.74	163.3		
Sum			61.100	84.5	3.605	<1.720	89.820	1,136.281	67.95	1053.6
Avg		1.44	12.220	16.9	0.721	<0.344	17.964	227.256	16.99	263.4
Max			16.200	22.4	1.220	<0.500	23.410	321.871	22.45	392.6
Min			6.500	11.1	0.441	<0.100	11.820	140.841	5.72	81.2

2016 Nitrogen Data

2016 Effluent Data	Rain Inches/Day	Daily Flow MGD	Ammonia Nh3 N mg/L	TKN mg/L	Nitrate NO3 mg/L	Nitrite NO2 mg/L	Nitrogen N Total mg/L	Nitrogen N Total Lbs/day	2015 Nitrogen N Total mg/L	2015 Nitrogen N Total Lbs/day
September										
9/6/2016	0	1.43	13.3	15.2	0.62	0.116	15.94	189.7	11.51	143.1
9/13/2016	0	1.26	23.7	25.1	<0.1	<0.1	25.3	266.6	16.75	192.2
9/20/2016	0	1.39	17.4	18.9	5.16	0.27	24.33	282.1	17.96	241.4
9/27/2016	0	1.45	9.73	10.1	4.72	0.239	15.06	182.1	22.5	304.8
									22.1	314.4
Sum			62.130	69.3	<10.600	<0.725	80.630	920.531	90.82	1195.9
Avg		1.35	15.532	17.3	<2.650	<0.181	20.158	230.133	18.16	239.2
Max			23.700	25.1	5.160	0.270	25.300	282.118	22.5	314.4
Min			7.730	10.1	<0.100	<0.100	15.060	182.144	11.51	143.1
October										
10/4/2016	0	1.31	7.14	10.2	9.38	0.376	19.96	218.2	16.12	219
10/11/2016	0	1.15	6.37	7	11.7	0.171	18.87	180.4	17.62	252.6
10/18/2016	0	1.34	11.5	12.9	11.9	0.588	25.39	283.8	16.38	222.9
10/25/2016	0	1.23	16.9	19.6	10.2	0.127	29.93	306.5	17.69	227.1
Sum			41.910	49.7	43.180	1.262	94.150	988.867	67.81	921.6
Avg		1.29	10.478	12.4	10.795	0.316	23.538	247.217	16.95	230.4
Max			16.900	19.6	11.900	0.588	29.930	306.529	17.69	252.6
Min			6.370	7.0	9.380	0.127	18.870	180.353	16.12	219
November										
11/1/2016	0	1.19	15.4	16.3	13.25	0.224	29.77	295.1	14.12	195
11/8/2016	0	1.24	8.12	9.45	15.35	0.293	25.09	260.3	22.68	357.1
11/15/2016	0.55	1.62	7.28	10	16.7	0.353	27.05	365.5	28.75	432.4
11/20/2016	0.3	1.68	7	9.17	17.5	0.274	26.94	376.5	23.94	405.9
11/29/2016	0.8	1.77	3.99	5.11	18.4	0.175	23.69	350		
Sum			41.790	50.0	81.200	1.319	132.540	1,647.372	89.49	1390.3
Avg		1.38	8.358	10.0	16.240	0.264	26.508	329.474	22.37	347.6
Max			15.400	16.3	18.400	0.353	29.770	376.543	28.75	432.4
Min			3.990	5.1	13.250	0.175	23.690	260.285	14.12	195
December										
12/6/2016	0.16	1.52	0.7	1.4	16.8	0.171	18.37	233	24.6	383.2
12/13/2016	0.35	1.46	0.98	2.03	20.4	<0.1	22.53	274.9	21.1	344.6
12/20/2016	0	1.38	2.59	3.99	17.4	<0.1	21.49	247.4	26.4	480.7
12/27/2016	0	1.73	2.59	2.87	18.8	<0.1	21.77	314.3	18.7	310.2
									9.69	203.9
Sum			6.860	10.3	73.400	<0.471	84.160	1,069.668	100.49	1722.6
Avg		1.55	1.715	2.6	18.350	<0.118	21.040	267.417	20.1	344.5
Max			2.590	4.0	20.400	0.171	22.530	314.336	26.4	480.7
Min			0.700	1.4	16.800	<0.100	18.370	232.976	9.69	203.9